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(71) Applicant *(for all designated States except US)*: **BRUNEL OILFIELD SERVICES (UK) LIMITED** [GB/GB]; 9 Burford Lane, Lymm, Cheshire WA13 0SE (GB).

(72) Inventor; and

(75) Inventor/Applicant *(for US only)*: **THORNTON, Thomas, John, Oliver** [GB/GB]; 9 Burford Lane, Lymm, Cheshire WA13 0SE (GB).

(74) Agents: **MCCALLUM, William, Potter** et al.; Cruikshank & Fairweather, 19 Royal Exchange Square, Glasgow G1 3AE (GB).

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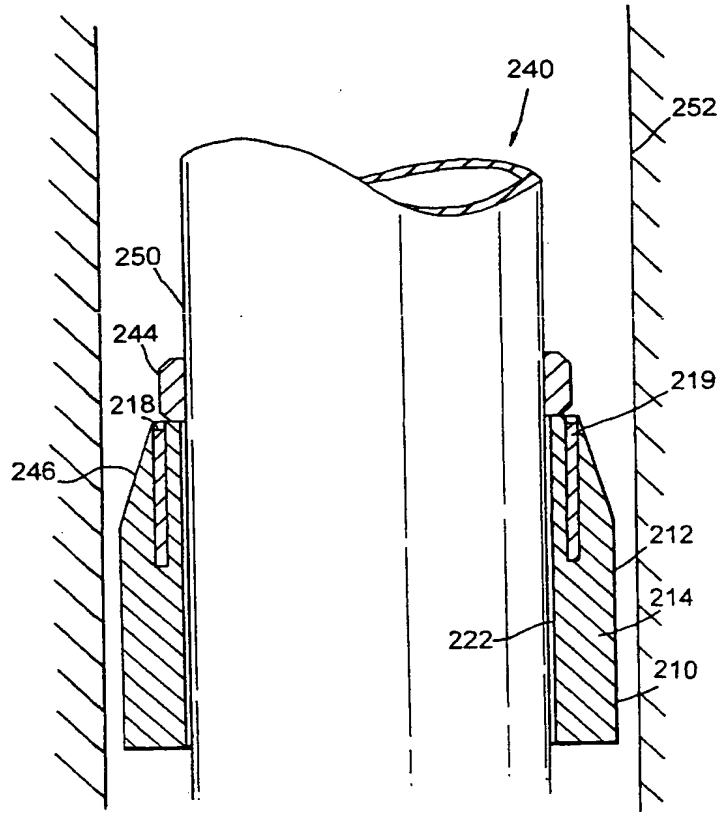
(54) Title: IMPROVEMENTS IN AND RELATING TO DOWNHOLE TOOLS



(57) Abstract: There is disclosed an improved centraliser (210) for centralisation of tubulars (250) such as casings, liners, production tubing, production screens and the like, in oil/gas wells. Known centralisers are of a "unitary construction", i.e. made in one piece fro m one material. This provides numerous problems in the prior art since the chosen material must provide conflicting characteristics at different times and places. Accordingly, the invention provides a centraliser (210) comprising a tubular body (214), a portion of an outermost surface (212) of said tubular body (214) being formed from a first material and a portion of or adjacent to at least one end (218) of said tubular body and/or a portion of an innermost surface (222) being formed from second material(s), the first material having a lower Youngs modulus than the second material(s).

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COMPOSITE CENTRALISER

FIELD OF INVENTION

This invention relates to downhole tools; particularly, though not exclusively, the invention relates to an improved centraliser for centralisation of tubulars such as casings, liners, production tubing, production screens and the like, in oil/gas wells.

BACKGROUND TO INVENTION

As a borehole is drilled it is necessary to secure the borehole walls to prevent collapsing and to provide a mechanical barrier to wellbore fluid ingress and drilling fluid egress. This is achieved by cementing in casings. Casings are tubular sections positioned in the borehole, and the annular space between the outer surface of the casing and the borehole wall is conventionally filled with a cement slurry.

After the well has been drilled to its final depth it is necessary to secure a final borehole section. This is performed by either leaving the final borehole section open (termed an open hole completion), or by lining the final borehole section with a tubular such as a liner (hung off the previous casing) or casing (extending to the surface), whereby the annular space between the liner or casing and the borehole is filled with a cement slurry (termed a cased hole completion).

The production tubing is then run into the lined hole and is secured at the bottom of the well with a sealing device termed a "packer" that seals the annulus so formed between this production tubing and the outer casing or liner. At the top of the well the production tubing is fixed to a wellhead/christmas tree combination. This production tubing is used to evacuate the hydrocarbon.

In some instances instead of running a final liner

string, the final borehole section is left open and screens are run. Screens are typically perforated production tubing having either slits or holes. These screens once in position act as a conduit in a procedure to fill the annular void between the borehole wall and the screen by placing sand around the screen. The sand acts as a filter and as a support to the borehole wall. The term used for this operation is "gravel packing".

In each case centralising a tubular within a borehole or within another tubular is necessary to ensure tubulars do not strike or stick against the borehole wall or wall of the other tubular, and that a substantially exact matching of consecutive tubulars positioned in the borehole is achieved, while allowing for an even distribution of materials, ie cement or sand, placed within the annulus formed.

Centralisers for drill-strings used to aid in the directing of a drill bit within a borehole are documented. More recently casing centralisers have been described which aim to keep the casing away from the borehole wall and/or aid the distribution of cement slurry in the annulus between the outer surface of the casing and the borehole wall. Examples of casing centralisers are:

US 5,085,981 (MIKOLAJCZYK) discloses a casing centraliser comprising a circumferentially continuous tubular metal body adapted to fit closely about a joint of casing, and a plurality of solid metal blades fixed to the body and extending parallel to the axis of the body along the outer diameter of the body in generally equally spaced apart relation, each blade having opposite ends which are tapered outwardly toward one another and a relatively wide outer surface for bearing against the well-bore or an outer casing in which the casing is disposed, including screws extending threadedly through holes in at least certain of the blades and the body for gripping the casing so as to hold the centraliser in place.

EP 0 671 546 A1 (DOWNHOLE PRODUCTS) discloses a casing centraliser comprising an annular body, a substantially cylindrical bore extending longitudinally through said body, and a peripheral array of a plurality of longitudinally extending blades circumferentially distributed around said body to define a flow path between each circumferentially adjacent pair of said blades, each said flow path providing a fluid flow path between longitudinally opposite ends of said centraliser, each said blade having a radial outer edge providing a well-bore contacting surface, and said cylindrical bore through said body being a clearance fit around casing intended to be centralised by said casing centraliser, the centraliser being manufactured wholly from a material which comprises zinc or a zinc alloy.

WO 98/37302 (DOWNHOLE PRODUCTS) discloses a casing centraliser assembly comprising a length of tubular casing and a centraliser of unitary construction (that is, made in one piece of a single material and without any reinforcement means) disposed on an outer surface of the casing, the centraliser having an annular body, and a substantially cylindrical bore extending longitudinally through the body, the bore being a clearance fit around the length of the tubular casing, characterised in that the centraliser comprises a plastic, elastomeric and/or rubber material.

WO 99/25949 to the present applicant also discloses an improved casing centraliser.

The content of the above-mentioned prior art documents are incorporated herein by reference.

As is apparent from the art, many centralisers have been developed to overcome known problems of centralising a tubular and distributing an annulus material. These centralisers are of unitary assembly and are made of a plastic, or more generally, a material such as zinc, steel or aluminium. However, in selecting a single material a

trade-off must be made as:

(a) the chosen material must provide a low friction surface against the smooth tubular outermost surface while being strong enough to withstand abrasion from rugeous borehole walls;

(b) the chosen material must act as a journal bearing once the centraliser is in its downhole location, but during the running operation it must act as a thrust bearing.

Material such as plastic deforms, and may potentially ride over stop rings or casing collars. This may occur when the centraliser contacts ledges (possibly the ledges within the BOP stack cavities and wellhead) when run in a cased hole, or to ledges and rugous boreholes when run in open hole. The centraliser is driven along the tubular in the opposite axial direction to that of the tubular motion and is driven into the rings and/or collars. Additionally, when the tubular is rotated (a common procedure when running tubular downhole, converting drag friction to torque friction) the "nose" of the centraliser is forced against a stop-collar and the tubular rotated thus causing the centraliser nose to act as a thrust bearing. If the centraliser deforms and rides over the collar, the stretched material may jam the centraliser, and possibly the tool or assembly against the borehole wall. This is illustrated in cross-section in Figure 1, where centraliser 110 lies between tubular 140 being centralised within borehole 152. Centraliser 110 of centralising apparatus 140 has been caused to stretch over stop collar 144 and as a result jammed outermost surface 112 of centraliser 110 against borehole wall 152.

It is an object of at least one embodiment of the present invention to obviate or at least mitigate at least one of the aforementioned disadvantages.

SUMMARY OF INVENTION

According to a first aspect of the present invention

there is provided a centraliser comprising a tubular body, a portion of an outermost surface of said tubular body being formed substantially from a first material and a portion of or adjacent to at least one end of said tubular body being formed substantially from a second material, the first material having a lower Youngs modulus or modulus of elasticity than the second material.

According to a second aspect of the present invention there is provided a centraliser comprising a tubular body, a portion of an outermost surface of said tubular body being formed substantially from a first material and a portion of an innermost surface of said tubular body being formed substantially from a second material, the first material having a lower Youngs modulus than the second material.

The centralisers of the first and second aspects may therefore be termed "composite" centralisers. These centralisers are therefore "non-unitary" in construction, that is to say, they are not formed in one piece from one material. They do however, offer a centraliser in which parts made from the first and second materials are static relative to one another, in use. In other words, the centralisers are effectively "one-piece".

The Applicant has termed the centraliser of the present invention the "EZEE-GLIDER" (Trade Mark).

Beneficially the centraliser may be a casing, liner or screen centraliser. However, it will be appreciated that the centraliser may be a production tubing centraliser or a drill tool or downhole tool.

In the first aspect, having a second material with a higher Youngs modulus and, therefore, increased stiffness and strength, eg at one or both ends of the centraliser, provides extra stability and strength to stop an end deforming when it strikes ledges, rings or collars during insertion or removal from a well.

In the second aspect the second material contacting

the smooth surface of the tubular being centralised can be advantageously made of a low friction material while the outermost surface can be made more of a rugged first material able to withstand collisions with an abrasive rugous borehole wall.

Advantageously the first material is selected from a material comprising a polymer or plastics material, rubber, an elastomeric material, a ceramic material, cermet or submicron grained cemented carbide, aluminium, or an aluminium alloy.

Each material has a number of advantages over the other.

The first material may have a Youngs modulus of 550,000 to 1,000,000 psi, and the second material may have a Youngs modulus of 10,000,000 psi or higher. Preferably the first material provides one or more of the following material characteristics as tested by ASTM (American Society for Testing and Materials):

Youngs Modulus	550,000 psi or 600,000 psi or higher (ASTM Test - Ref D638)
Tensile strength	10,000 psi or higher (ASTM Test - Ref D638)
Friction Factor (co-efficient of Friction)	0.35 or lower ASTM Test - Dry (thrust washer) against steel
Izod input test (notched)	1.6 and preferably 3.2 ft - lb/in or higher (ASTM Test Ref D256)
HDT (Heat Deflection or Distortion Temperature)	greater than 185°C (ASTM Test Ref D648 at 66 psi)

Chemical resistance	Able to withstand chemical attack from most common reagents found in a drilling environment, eg hydrocarbons, brines, weak alkalis and weak acids
Specific gravity	1.28

In one implementation the first material may be a polyphthalamide (PPA), eg a glass-reinforced heat stablilised PPA such as AMODEL, eg AMOEL-AT-1116 HS resin available from BP Amoco, (see http:/www.bpamocoengpolymers.com).

In another implementation the first material may be a polymer of carbon monoxide and alpha-olefins, such as ethylene.

Advantageously, the first material may be an aliphatic polyketone made from co-polymerisation of ethylene and carbon monoxide - optionally with propylene.

Advantageously, the first material may be CARILON (Trade Mark) available from Shell Chemicals. CARILON (Trade Mark) is a class of semi-crystalline thermoplastic materials with an alternating olefin - carbon monoxide structure.

In a further implementation the first material may be a nylon resin.

Advantageously the first material may be an ionomer modified nylon 66 resin.

The first material may be a nylon 12 resin, e.g. RILSAN (Trade Mark) available from Elf Atochem.

In a yet further alternative implementation the first material may be a modified polyamide (PA).

The first material may be a nylon compound such as DEVLON (Trade Mark) available from Devlon Engineering Ltd.

The first material may be of the polyetheretherketone

family, EG PEEK (Trade Mark) available from Victrex PLC.

The first material may be ZYTEL (Trade Mark) available from Du Pont. ZYTEL (Trade Mark) is a class of nylon resins which, includes unmodified nylon homopolymers (e.g. PA 66 and PA 612) and copolymers (e.g. PA 66/6 and PA 6T/MPMDT etc) plus modified grades produced by the addition of heat stabilizers, lubricants, ultraviolet screens, nucleating agents, toughеners, reinforcements etc. The majority of resins have molecular weights suited for injection moulding, roto-moulding and some are used in extrusion.

Alternatively the first material may be VESCONITE (Trade Mark) available from Vesco Plastics Australia Pty Ltd.

Alternatively the first material may be polytetrafluoroethylene (PTFE).

In such case the first material may be TEFLON (Trade Mark) or a similar type material. TEFLON (Trade Mark) filled grades of PEEL CARILON (Trade Mark) may be used. These materials are suitable for roto-moulding which is a favoured method of manufacture for economic reasons for larger component sizes, eg greater than 9 5/8". Alternatively, the first material may be PA66, FG30, PTFE 15 from ALBIS Chemicals.

The ceramic material may be, for example, zirconia, titania and/or aluminia. The ceramic material may be toughened by addition of a further material, for example, zirconia with the addition of alumina.

Alternatively, the first material may be a metal. Preferably, the metal is a soft metal such as aluminium.

The outermost surface of said body may provide or comprise a plurality of raised portions.

The raised portions may be in the form of longitudinally extending blades or ribs or may alternatively be in the form of an array of nipples or lobes.

Adjacent raised portions may define a flow path therebetween such that fluid flow paths are defined between first and second ends of the tubular body.

Where the raised portions comprise longitudinal blades, such blades may be formed, at least in part, substantially parallel to an axis of the tubular body.

Alternatively, the blades may be formed in a longitudinal spiral/helical path on the tubular body.

Advantageously adjacent blades may at least partly longitudinally overlap upon the tubular body.

Preferably adjacent blades may be located such that one end of a blade at one end of the tubular body is at substantially the same longitudinal position as an end of an adjacent blade at another end of the tubular body.

More preferably, the blades may have an upper spiral portion, a middle substantially straight portion and a lower tapered portion.

Advantageously the second material may be a metallic material.

Preferably, the second material may be a bronze alloy such as phosphur bronze or lead bronze, or alternatively, zinc or a zinc alloy.

In a preferred embodiment the second material is lead bronze. Bronze is advantageously selected as it has a high Youngs Modulus (16,675,000 psi) compared to CARILON (around 900,000 psi) ZYTEL (around 600,000 psi) and AMODEL (870,000 psi) while having friction properties which are better than steel.

Preferably, in the first aspect at least a portion of an innermost surface of the tubular body may be formed from the second material.

Advantageously, the innermost surface is formed from the second material.

This arrangement provides an inner core with good strength, low friction properties and shock loading.

Preferably, in the second aspect a portion of or

adjacent to first and/or second ends of the tubular body may be formed from the second material.

The second material may be arranged in an annulus of a body of the first material.

More preferably there are two annular bodies of the second material each located at respective ends of the body of the first material.

Additionally, the centraliser may include a reinforcing means such as a cage, mesh, bars, rings and/or the like. The reinforcing means may be made from the second material.

At least part of the centraliser according to the first or second aspects of the present invention may be formed from a casting process.

Alternatively or additionally, at least part of the centraliser according to the first or second aspects of the present invention may be formed from an injection moulding process.

Advantageously, at least part of the centraliser according to the first or second aspects of the present invention may be formed from an injection moulding or roto-moulding process.

Advantageously, also a body of the second material may be retained relative to a body of the first material by an interference fit.

It will be appreciated that the polymeric materials mentioned above may include filler materials, as is known in the polymer art.

The first material may be around a factor of four times lighter than the second material in air, but may be around a factor of ten times lighter than the second material in water.

According to a third aspect of the present invention there is provided a centralising apparatus for use in a well-bore, the centralising apparatus including a tubular section and at least one centraliser located thereupon,

wherein the centraliser comprises a tubular body, a portion of an outermost surface of said tubular body being formed from a first material and a portion of or adjacent to at least one end of said tubular body being formed from a second material, the first material having a lower Youngs modulus than the second material.

According to a fourth aspect of the present invention there is provided a centralising apparatus for use in a well-bore, the centralising apparatus including a tubular section and at least one centraliser located thereupon, wherein the centraliser comprises a tubular body, a portion of an outermost surface of said tubular body being formed from a first material and a portion of an innermost surface of said tubular body being formed from a second material, the first material having a lower Youngs modulus than the second material.

In a first preferred embodiment the tubular section may be a well-bore casing or liner.

In a second embodiment the tubular section may be a length of production tubing.

In a third embodiment the tubular section may be a screen.

The at least one centraliser may be located so as to surround the tubular section, i.e. the tubular section may be located within the at least one centraliser.

The at least one centraliser may be located relative to the tubular section by means of a collar.

The at least one centraliser may be located relative to the tubular section, and may be rotatable relative to the tubular section around a longitudinal axis thereof.

According to a fifth aspect of the present invention there is provided a method of fixing a casing or liner into a well-bore, the method comprising the steps of:

providing a well casing/liner;

providing at least one centraliser, the/each

centraliser comprising a tubular body, a portion of an outermost surface of said tubular body being formed from a first material and a portion of or adjacent to at least one end of said body and/or an innermost surface of said tubular body being formed from a second material, the first material having a lower Youngs modulus than the second material;

locating the at least one centraliser on the casing/liner at a desired position so as to provide a centralising apparatus;

placing the centralising apparatus within the well-bore; and

pumping cement slurry or the like into an annular space between an exterior of the casing/liner and the well-bore.

According to a sixth aspect of the present invention there is provided a method of completing a well, the method comprising the steps of:

providing a length of production tubing;

providing at least one centraliser, the/each centraliser comprising a tubular body, a portion of an outermost surface of said tubular body being formed from a first material and a portion of or adjacent to at least one end and/or an innermost surface of said tubular body being formed from a second material, the first material having a lower Youngs modulus than the second material;

locating the at least one centraliser on the production tubing at a desired position so as to provide a centralising apparatus;

placing the centralising apparatus within a cased or lined well-bore.

Preferably the method comprises the further step of:

securing a bottom of a length of the production tubing with a packer to seal the tubing to a casing/liner.

According to a seventh aspect of the present invention there is provided a method of gravel packing a well, the

method including the steps of:

providing a screen;

providing at least one centraliser, the/each centraliser comprising a tubular body, a portion of an outermost surface of said tubular body being formed from a first material and a portion of or adjacent to at least one end and/or an innermost surface of said tubular body being formed from a second material, the first material having a lower Youngs modulus than the second material;

locating the at least one centraliser on the screen to provide a centralising apparatus;

placing the centralising apparatus within a borehole or perforated casing.

Preferably the method comprises the further step of:

placing sand into an annular space between an exterior of the screen and the well-bore or perforated casing.

BRIEF DESCRIPTION OF DRAWINGS

A number of embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings which are:

Figure 1 a cross-sectional view of a prior art centralising apparatus within a well-bore;

Figure 2 a cross-sectional view of a centralising apparatus according to a first embodiment of the present invention;

Figure 3 a perspective view from one side and above of a centraliser according to a second embodiment of the present invention;

Figure 4 a perspective view from one side and above of a centraliser

according to a third embodiment of the present invention;

Figure 5 a side view of a centraliser according to a fourth embodiment of the present invention;

Figures 6(a) and (b) cross-sectional views of the centraliser of Figure 5 along section lines A - A and B - B, respectively;

Figures 7 (a) - (h) examples of outermost surfaces of centralisers according to modifications of embodiments of the present invention;

Figures 8(a) - (d) cross-sectional views of various modifications to the centraliser of Figure 5 taken through section line B - B;

Figure 9 a perspective view from one side and above of a centraliser according to a fifth embodiment of the present invention;

Figure 10 A perspective view from one side and above of a centralising apparatus according to a sixth embodiment of the present invention;

Figure 11 a perspective view of a centralising apparatus positioned within a well-bore for cementing a well according to a seventh embodiment of the present invention;

Figure 12 a perspective view of a centralising apparatus positioned within a casing/liner for

completing a well according to an eighth embodiment of the present invention;

Figures 13(a) and (b) perspective views of a centralising apparatus positioned within a borehole and within a perforated casing respectively, for gravel packing a well according to ninth and tenth embodiments of the present invention;

Figures 14(a) and (b) side and end cross-sectional views of a centralising apparatus according to an eleventh embodiment of the present invention;

Figures 15(a) and (b) side and end cross-sectional views of a centralising apparatus according to a twelfth embodiment of the present invention; and

Figures 16(a) and (b) side and end cross-sectional views of a centralising apparatus according to a thirteenth embodiment of the present invention.

DETAILED DESCRIPTION OF DRAWINGS

Reference is initially made to Figure 1 of the drawings which depicts a centralising apparatus, generally indicated by reference numeral 140 as an example of the prior art. Centralising apparatus 140 is located within borehole 152. Centralising apparatus 140 comprises tubular 150 and centraliser 110. The tubular 150 includes a stop collar 144. Centraliser 110 is made of a unitary construction, ie of a single piece of polymeric material

such as a plastic, elastomeric or rubber material. Demonstrated in Figure 1 is an example of what may occur when the centraliser 110 strikes a ledge or other obstruction when being run. Outermost surface 112 of centraliser 110 sticks at a contact point. The tubular 150 is driven against the centraliser end 118 which will ride over the stop collar 144. Rounded edges on the end 118 can exacerbate the problem. Nose 146 of the centraliser 110 deforms as the plastic material is forced over the stop collar 144. As a result both centraliser 110 and tubular 150 become stuck in the bore hole. Time and costs arise in withdrawing the tubular 150 and replacing the centraliser 110.

Figure 2 shows a first embodiment of the present invention which addresses one or more of the disadvantages of the prior art. Centralising apparatus 240 comprises a tubular 250 with stop collar 244 and centraliser 210. Centralising apparatus 240 is located within borehole 252. The centraliser 210 comprises a tubular body 214, a portion of an outermost surface 212 is formed from a first material and a portion of at least one end 218 is formed from a second material, ie insert band 219. The first material has a lower Youngs modulus than the second material. The centraliser 210 is a "composite centraliser", termed "EZEE-GLIDER" (Trade Mark) by the Applicant. A detailed description of the centraliser 210 is provided hereinafter.

As the second material has a higher Youngs modulus than the first material, the centraliser 210 has an increased stiffness and strength at end 218. Thus centraliser 210 has a body 214 which provides an innermost surface 222 and an outermost surface 212. Advantageously the increased strength at the end 218 helps to prevent the nose 246 deforming if it strikes or is struck by a stop collar 244.

Referring now to Figure 3, there is shown a second embodiment of a centraliser for a tubular (e.g. a casing,

liner, screen or even production tubing, or the like), generally designated 10, according to the present invention. At least a portion of an outermost surface 12 of the centraliser 10 is selected from a first material advantageously providing a good tribiological performance and comprising a polymeric/plastics material, rubber, an elastomeric material, a ceramic material, cermet or submicron grained carbide. In one form of this embodiment the first material is a thermoplastic polymer, particularly a polymer of carbon monoxide and alpha-olefins, and more particularly CARILON (Trade Mark) available from Shell Chemicals, as will hereinafter be discussed in greater detail. In an alternative, and preferred form of this embodiment, the first material is a polyphthalamide (PPA), such as AMODEL available from BP Amoco. AMODEL is a semi-crysallilne polymer offering good mechanical properties over a broad temperature range. AMODEL exhibits a high Heat Deflection Temperature (HTD), high flexural modulus and high tensile strength, as well as good creep resistance and low moisture absorption. In a further form of this embodiment the material is polytetrafluoroeth(yl)ene (PTFE), and particularly TEFLON (Trade Mark). In a yet further alternative form of this embodiment the material is a ceramic material, for example, selected from zirconia, titania, and/or alumina perhaps toughened with titanium carbide, or alternatively a titanium based ceramic, perhaps with additions or aluminium/boron and nitrogen, or alternatively silicon nitride.

The centraliser 10 comprises a tubular body 14. The tubular body 14 has a bore 16 extending longitudinally therethrough. The body 14 is provided with outermost surface 12 and ends 18 to 20. Each end 18, 20 is formed from a selected second material, e.g. a metallic material. In an embodiment of the present invention, the ends 18, 20 are made of phosphur bronze. In an alternative embodiment the ends 18, 20 are made of lead bronze. This selection of

materials ensures that the ends 18, 20 or "nose" of the centraliser 10 has a higher Youngs modulus than that of the body 16, and has friction properties better than steel. The Youngs modulus of CARILON/ZYTEL/AMODEL (Trade Marks) is around 900,000 psi compared to 16,675,000 psi for bronze. Thus in bronze, a stress of circa 20 times that required to deform a plastic end 18, 20 is required. To deform either end 18, 20 over a stop collar (3% strain) requires +/- 4 tonnes for CARILON/ZYTEL/AMODEL (Trade Marks), but 88 tonnes bronze. In use, the likely loading is likely in the 10 to 20 tonnes range.

Reference is now made to Figure 4 of the drawings which depicts a centraliser 10a, having ends 18a, 20a and an innermost surface 22a and outermost surface 12a. In this embodiment the outermost surface 12a comprising a first material, e.g. a polymeric/plastics material, rubber, an elastomeric material, a ceramic material, cermet or submicron grained carbide. In one form of this embodiment the first material is a thermoplastic polymer, particularly a polymer of carbon monoxide and alpha-olefins and more particularly CARILON (Trade Mark) available from Shell Chemicals, as will hereinafter be discussed in greater detail. In an alternative, and preferred form of this embodiment, the first material is polyphthalmide (PPA) such as AMODEL available from BP Amoco. In a yet further form of this embodiment the material is polytetrafluoroeth(yl)ene (PTFE), and particularly TEFLON. In a yet further alternative form of this embodiment the first material is a ceramic material, for example selected from zirconia, titania, and/or alumina perhaps toughened with titanium carbide, or alternatively a titanium based ceramic, perhaps with additions or aluminium/boron and nitrogen, or alternatively silicon nitride. This provides a tough abrasive resistant outer body. Ends 18a, 20a and the innermost surface 12a are constructed from lead bronze. This composite centraliser 10a has the advantages of a

rigid inner body providing an improved journal bearing and also ends for good thrust load bearing.

CARILON (Trade Mark) is a semi-crystalline aliphatic polyketone as disclosed in Shell Chemical Literature available from their web-site http://www.shellchemical.com as at 10 November, 1998 and included herein by reference.

According to the literature CARILON (Trade Mark) is characterised by the following:

- Short moulding cycles and good mould definition
- Low warpage and no need for post-moulding conditioning
- Superior resilience and snapability
- Very good impact performance over a broad temperature range
- Very good chemical resistance and barrier performance
- Very good hydrolytic stability
- Good friction/wear characteristics and low noise generation

A range of CARILON (Trade Mark) is used depending on the performance required and the fabrication method, i.e. extrusion or injection moulding. The current range is:

- SC:2544-97 - CARILON® D26CX100 -- Advanced extrusion grade
- SC;2545-97 - CARILON® D26FX100 -- General purpose extrusion grade
- SC:2546-97 - CARILON® D26HM100 -- General purpose injection moulding grade
- SC:2547-97 - CARILON® D26VM100 -- High-flow injection moulding grade
- SC:2548-97 - CARILON® DB6G3A10 -- 15% Glass reinforced general-purpose injection moulding grade
- SC:2549-97 - CARILON® DB6GA10 -- 30% Glass reinforced general-purpose injection moulding grade
- SC;2550-97 - CARILON® DB6F0A10 -- Flame retarded (V-O), injection moulding grade
- SC:2551-97 - CARILON® DB6F5G40 -- Flame retarded (V-O), 20% glass reinforced, injection moulding grade

- SC:2552-97 - CARILON® DB6F1G40 -- Flame retarded (V-1) tracking resistance 15% glass reinforced injection moulding grade
- SC:2533-97 - CARILON® DA6L1A10 -- Lubricated injection moulding grade
- SC:2554-97 - CARILON® DA6P2L10 -- High performance lubricated injection moulding grade
- SC:2557-97 - CARILON® DB6G6P30 -- Lubricated glass reinforced injection moulding grade

For some environments ZYTEL (Trade Mark) can be used. ZYTEL (Trade Mark) is a nylon resin available from Du Pont which can be injection moulded, and is disclosed on their web-site http://www.dupont.com as at 12th November 1998, included herein by reference. Currently thirteen grades of ZYTEL (Trade Mark) can be used, namely:

- 408L NCO — Ionomer modified nylon 66 resin
- 450HSL BK 152 — Olefinic/rubber modified nylon 66 resin
- 3189 NC010 — Cube blend, stiff, rubber modified nylon 66 resin
- FN718 010 — Flexible grafted ionomer modified nylon 66 resin
- FN714 NC010 — Very flexible grafted ionomer modified nylon 66 resin
- CFE4003HS BK245 — Heat stabilized toughened black nylon 66 resin
- CFE4004HS NC010 — Heat stabilised toughened nylon 66 resin
- CFE4005HS BK246 — Heat stabilized highly toughened black nylon 66 resin
- CFE4006HS NC010 — Heat stabilized highly toughened nylon 66 resin which are toughened nylons and
- ST801 NC010 — Grafted rubber modified nylon 66 resin
- ST801W NC010 — Grafted rubber modified nylon 66

resin

- ST901L NC095 Grafted rubber modified nylon 66 resin
- ST901L NC010 Grafted rubber modified amorphous nylon resin

which are super tough nylons.

A further alternative plastic material which can be used in VESCONITE (Trade Mark). It is available from Vesco Plastics Australia Pty Ltd. VESCONITE (Trade Mark) exhibits greater hardiness, lower friction, negligible water absorption and higher chemical resistance than nylon. VESCONITE (Trade Mark) can be machined. Of better quality is VESCONITE HILUBE (Trade Mark) which can be injection moulded.

Referring now to Figure 5 there is illustrated a centraliser 10b according to a fourth embodiment of the present invention. The centraliser 10b is of composite construction with ends 18b, 20b and innermost surface 22b, as shown in Figures 4a and 4b, comprising of a lead bronze body 100b bonded to a tough abrasion resistant material body 105b, in this embodiment CARILON (Trade Mark) or AMODEL (Trade Mark), providing outermost surface 12b. The outermost surface 12b of the body includes a number of raised portions in the form of longitudinally extended blades 24 or ribs. Adjacent blades define a flow path between the ends 18b, 20b of the body 14b. The blades 24 are parallel to an axis of the tubular body 14b.

Figures 7(a)-(h) show a variety of outermost surfaces 12c-j which can be made in a plastics material, by way of example. Ends and innermost surfaces have been omitted from these figures to aid clarity. Figures 7(b) and 7(c) illustrate arrays of nipples 26d or lobes 28e as the raised portions.

Figures 7(a), 7(d)-(h) show an outermost surface of raised portions in the form of blades 24c,f-j wherein adjacent blades partly longitudinally overlap on the

tubular body 14c-j. For some embodiments e.g. Figures 7(a), 7(f), 7(g) and 7(h) adjacent blades are located such that one end of a blade 25c,h-j at one end 18c,h-j, the tubular body 14c,h-j at the same longitudinal position as an end 27c,h-j of an adjacent blade at another end 20c,h-j of the tubular body 14c,h-j. Figures 7(d) and 7(e) illustrate blades 24f,g having an upper spiral section 25f,g a middle substantially straight section 23f,g and a lower tapered section 27f,g. In these embodiments the outermost surfaces 12c-j may be moulded, eg injection moulded, at surface 14c-j, onto a metallic tubular body (not shown).

Reference is now made to Figure 8 which shows a series of modified embodiments, each shown through section B-B of Figure 5, of modifications to the centraliser 10b according to the present invention. These Figures 8(a) - (d) illustrate, by way of example only, possible arrangements of the two materials which make up the centraliser 10b.

Figure 8(a) shows ends 18k, 20k having portions of a second material, preferably leaded bronze, bonded or otherwise fixed (e.g. by an interference fit) to a tubular body 14k by a snap ring type arrangement. Innermost 22k and outermost 12k surfaces are formed from the first material, preferably CARILON (Trade Mark) or AMODEL (Trade Mark), as described hereinbefore.

In Figure 8(b), ends 181, 201 have smaller bonded sections of leaded bronze arranged as a ring around the tubular body 141.

Figures 8(c) and 8(d) illustrate embodiments where the second material is a ring sited at each end, but away from annular faces 25m,n, 27m,n of the ends. In these embodiments part of the innermost surface, part of the outermost surface and/or part of end surfaces are all made of the first material, eg CARILON (Trade Mark) or AMODEL (Trade Mark) . The second material, leaded bronze, formed in an integral ring or annulus provides stability and

rigidity to the centraliser 10b.

The centraliser 10b may be formed from an injection moulding process. Alternatively, the centraliser 10b may be formed from a casting process. Advantageously, the centraliser 10b is formed from a roto-moulding process. Those of skill in the art will appreciate the appropriate process for each embodiment shown. For some embodiments eg Figures 5 to 6(b), the second material may be cast while the first material is injection moulded as a plastic coating over a metallic body. Thus the second material may be "bonded" to the first.

Reference is now made to Figure 9 of the drawings which depicts a centraliser, generally indicated by reference numeral 10w, according to a fifth embodiment of the present invention. Centraliser 10w includes a tubular body 14w which is of a second material preferably a metallic material. A portion 24w of the outermost surface 12w of the centraliser 10w is of a first material preferably a plastics material, rubber or elastomeric material. The first material has a lower Youngs modulus than the second material. The portion of the outermost surface 12w comprises a series of longitudinally extending blades 24w. The blades 24w may be modified to have a shape, position and orientation as shown in Figures 7(a),(d)-(h). When assembled, the blades 24w are attached to outermost surface 12w of the body 14w, e.g. by bonding, bolting, screwing or the like, at connection points 31w.

Referring now to Figure 10 there is illustrated centralising apparatus, generally indicated by reference numeral 40p, according to a sixth embodiment of the present invention. The apparatus 40p comprises a tubular section 42p onto which is mounted at least one centraliser 10p as described hereinbefore. The centraliser 10p includes an outermost surface 12p as described hereinbefore with reference to Figures 7(d) and 7(e). The outermost surface is made of a first material preferably CARILON (Trade Mark)

or AMODEL (Trade Mark). Ends 18p, 20p are formed from a second material, preferably leaded bronze such that the first material has a lower Youngs modulus than the second material. The innermost surface (not shown) may be made of the first material or beneficially of the second material. The tubular section 42p may be a casing, liner, production tubing or screen. The centraliser 10p may be rotatable relative to the tubular section 42p along a longitudinal axis thereof. Additionally illustrated in Figure 10 is a stop collar 44p. Stop collars 44p may be positioned on the tubular section 42p at either end of the centraliser 10p.

During the running of the tubular section 42p the outermost surface 12p of the centraliser 10p may contact ledges, possibly the ledges within the BOP stack cavities and wellhead when run in a cased hole, or to ledges and rugous boreholes when run in an open hole. The effect of the centralisers end 18p being subjected to such forces is to drive the centraliser 10p along the tubular 42p in the opposite axial direction to that of the tubular motion. Thus "nose" 46p of the centraliser 10p is driven into the stop ring or casing collar 44p. When the tubular 42p is rotated (a common procedure when running tubular downhole, converting drag friction into torque friction) the centraliser nose 46p will be forced against the stop collar 44p and the tubular 42p then rotated thus causing the centraliser nose 46p to act as thrust bearing.

If the nose 46p is made of a material that is a thermoplastic material, an aluminium material or some lower Youngs Modulus material, the centraliser 10p may ride over the collar 44p, thus being stretched, so creating the possibility of jamming the centraliser 10p against the borehole wall. In the present invention the nose 46p of the centraliser 40p is of a material with a higher Youngs modulus than that of the body material, yet has friction properties better than steel. For the preferred embodiment, the body material is CARILON (Trade Mark) or

AMODEL (Trade Mark) where the Youngs modulus of CARILON/ZYTEL/AMODEL (Trade Marks) is around 900,000 psi and AMODEL is 870,000 psi and the "nose" or end material is leaded bronze where the Youngs modulus is 16,675,000 psi. In bronze, a stress of circa 20 times that required to deform the plastic nose is required. To deform the nose 46p over the top collar 44p (3% strain) requires +/- 4 tonnes CARILON, 88 tonnes bronze. In use, the likely loading is in the 10 to 20 tonnes range.

Referring to Figure 11, there is illustrated a seventh embodiment of a centralising apparatus 40q similar to the centralising apparatus 40p of Figure 10. In Figure 11 where the tubular section of 42q of the centralising apparatus 40q is a casing or liner 50q, in use, the apparatus 40q is located within a well bore 52q such that the innermost surface 22q of the at least one centraliser 10q is a clearance fit rotatable around the casing or liner 50q while the outermost surface 12q contacts the borehole walls.

In use, the centraliser 10q may aid cementing of a well. The casing or liner 50q is cemented into the well bore 52q, by the following method steps of:

providing a well casing/liner 50q;

providing the at least one centraliser 10q;

locating the least one centraliser 10q on the casing/liner 50q at a desired position so as to provide a centralising apparatus 40q;

placing the centralising apparatus 40q within the well bore 52q; and

pumping cement slurry 70q into an annular space 72q between an exterior of the casing/liner 50q and the well bore 52q.

Referring now to Figure 12, where the tubular section 42r of the centralising apparatus 40r is a length of a production tubing 54r, in use, the apparatus 40r is located within a casing or liner 56r located in a borehole 58r such

that the innermost surface 22r of the centraliser 10r is a clearance fit rotatable around the production tubing 54r while the outermost surface 12r contacts the innermost surface 60r of the casing or liner 56r.

In use, the centraliser 10r may aid completion of a well. This method of completing a well comprises the steps of:

providing a length of the production tubing 54r;

providing the at least one centraliser 10r;

locating the at least one centraliser 10r on the production tubing 10r at a desired position so as to provide centralising apparatus 40r;

placing the centralising apparatus 40r within a cased or lined well bore 58r; and

securing a bottom 74r of the length of production tubing 54r with a packer 76r to seal the tubing 54r to the casing/liner 56r.

Referring now to Figure 13(a), where the tubular section 42s of the centralising apparatus 40s is a screen 62s, the screen 62s being a section of production tubing including slots or holes, the apparatus 40s is located within the open hole end of a borehole 64s. The outermost surface 12s of the centraliser 10s will contact the borehole wall 66s while the innermost surface 22s of the centraliser 10s is a clearance fit rotatable around the screen 62s.

Alternatively, as sown in Figure 13(b), apparatus 40t may be located at a section of perforated casing 66t within borehole 64t wherein the centraliser 10t is then located between the outer surface of the screen 68t and the perforated casing 66t.

In use the centralisers 10s, 10t may aid in the gravel packing of a screen 62s,68t in a well. This method of gravel packing a well includes the steps of:

providing screen 62s, 68t;

providing the at least one centraliser 10s,10t;

locating the at least one centraliser 10s,10t on the screen 62s,68t to provide centralising apparatus 40s,40t;

placing the centralising apparatus 40s,40t within a borehole 64s or perforated casing 66t; and

placing sand 78s,78t into an annular space between an exterior of the screen 62s,68t and the well bore 64s or perforated casing 68t.

It will be appreciated that a principle advantage of the present invention is to provide a centraliser for centralising a drilltool or downhole tubular which has the combined advantages of a rigid construction to prevent deformation of the centraliser when thrust against collars or stops, while providing a centraliser with a low friction outer surface for ease of installation within, eg a bore-hole or casing.

It will be appreciated by those skilled in the art that the embodiments of the invention hereinbefore described are given by way of example only, and are not meant to limit the scope of the invention in any way. It is noted that the term "centraliser" has been used herein; however it will be appreciated that the device also acts as a "glider". In addition though the disclosed embodiments illustrate symmetrical centralisers, it will be appreciated that the second material may be provided only at a single end of the centraliser.

Further, it will be appreciated that a benefit of the embodiments hereinbefore disclosed is the provision of electrical isolation between the tubular body centralised by the centraliser, and any object or surface which the outerside of the centraliser touches or otherwise rests against. In such case the invention does not need provision of blades etc, and the invention comprises a downhole tool in the form of an electrical isolator/sheath/sleeve, eg 25 to 30 ft in length.

CLAIMS

1. A centraliser comprising a tubular body, a portion of an outermost surface of said tubular body being formed substantially from a first material and a portion of or adjacent to at least one end of said tubular body being formed substantially from a second material, the first material having a lower Youngs modulus than the second material.

2. A centraliser comprising a tubular body, a portion of an outermost surface of said tubular body being formed substantially from a first material and a portion of an innermost surface of said tubular body being formed substantially from a second material, the first material having a lower Youngs modulus than the second material.

3. A centraliser as claimed in either of claims 1 or 2, wherein the centraliser is selected from a casing, liner or screen centraliser, or a production tubing centraliser.

4. A centraliser as claimed in any of claims 1 to 3, wherein the first material is selected from a material substantially comprising a polymer or plastics material, rubber, an elastomeric material, a ceramic material, cermet or submicron grained cemented carbide, aluminium, or an aluminium alloy.

5. A centraliser as claimed in any of claims 1 to 4, wherein the first material has a Youngs modulus of 5,500,000 to 1,000,000 psi, and the second material has a Youngs modulus of 10,000,000 psi or higher.

6. A centraliser as claimed in any of claims 1 to 4, wherein the first material is a polyphthalamide (PPA).

7. A centraliser as claimed in any of claims 1 to 4, wherein the first material is a polymer of carbon monoxide and alpha-olefins.

8. A centraliser as claimed in any of claims 1 to 4, wherein the first material is an aliphatic polyketone made from co-polymerisation of ethylene and carbon monoxide - optionally with propylene.

9. A centraliser as claimed in claim 8, wherein the first material is a semi-crystalline thermoplastic material with an alternating olefin - carbon monoxide structure.

10. A centraliser as claimed in any of claims 1 to 4, wherein the first material is a nylon material.

11. A centraliser as claimed in any of claims 1 to 4, wherein the first material is a polyamide (PA).

12. A centraliser as claimed in any of claims 1 to 4, wherein the first material is a polyetheretherketone.

13. A centraliser as claimed in any of claims 1 to 4, wherein the first material is polytetrafluoroethylene (PTFE).

14. A centraliser as claimed in claim 4, wherein the ceramic material is zirconia, titania and/or aluminia.

15. A centraliser as claimed in any preceding claim, wherein the outermost surface of said body provides or comprise a plurality of raised portions.

16. A centraliser as claimed in claim 15, wherein the raised portions are in the form of longitudinally extending blades or ribs or an array of nipples or lobes.

17. A centraliser as claimed in either of claims 15 or 16, wherein adjacent raised portions define a flow path therebetween such that fluid flow paths are defined between first and second ends of the tubular body.

18. A centraliser as claimed in either of claims 16 or 17, wherein where the raised portions comprise longitudinal blades, such blades are formed, at least in part, substantially parallel to an axis of the tubular body.

19. A centraliser as claimed in either of claims 16 or 17, wherein the blades are formed in a longitudinal spiral or helical path on the tubular body.

20. A centraliser as claimed in claim 19, wherein adjacent blades at least partly longitudinally overlap upon the tubular body.

21. A centraliser as claimed in claim 20, wherein adjacent blades are located such that one end of a blade at one end of the tubular body is at substantially the same longitudinal position as an end of an adjacent blade at another end of the tubular body.

22. A centraliser as claimed in claim 16, wherein the blades have an upper spiral portion, a middle substantially straight portion and a lower tapered portion.

23. A centraliser as claimed in any preceding claim, wherein the second material is a metallic material.

24. A centraliser as claimed in claim 23, wherein the second material is a bronze alloy such as phosphor bronze or lead bronze, or alternatively, zinc or a zinc alloy.

25. A centraliser as claimed in any of claims 3 to 24 when dependent on claim 1, wherein at least a portion of an innermost surface of the tubular body is formed from the second material.

26. A centraliser as claimed in claim 2 or any of claims 3 to 25 when dependent on claim 2, wherein a portion of or adjacent to first and/or second ends of the tubular body are formed from the second material.

27. A centraliser as claimed in claim 2, wherein a body of the second material is arranged within an annulus of a body of the first material.

28. A centraliser as claimed in claim 1, wherein there are two annular bodies of the second material each located at respective ends of a body of the first material.

29. A centraliser as claimed in any preceding claim, wherein the centraliser includes a reinforcing means such as a cage, mesh, bars, rings and/or the like.

30. A centraliser as claimed in claim 29, wherein the reinforcing means are made of the second material.

31. A centraliser as claimed in any preceding claim, wherein at least part of the centraliser is formed from a casting process.

32. A centraliser as claimed in claim 31, wherein at least part of the centraliser invention is formed from an injection moulding or roto-moulding process.

33. A centraliser as claimed in any preceding claim, wherein a body of the second material is retained relative

to a body of the first material by an interference fit.

34. Centralising apparatus for use in a well-bore, the centralising apparatus including a tubular section and at least one centraliser located thereupon, wherein the centraliser comprises a tubular body, a portion of an outermost surface of said tubular body being formed from a first material and a portion of or adjacent to at least one end of said tubular body being formed from a second material, the first material having a lower Youngs modulus than the second material.

35. Centralising apparatus for use in a well-bore, the centralising apparatus including a tubular section and at least one centraliser located thereupon, wherein the centraliser comprises a tubular body, a portion of an outermost surface of said tubular body being formed from a first material and a portion of an innermost surface of said tubular body being formed from a second material, the first material having a lower Youngs modulus than the second material.

36. A centraliser apparatus as claimed in either of claims 34 or 35, wherein, the tubular section is a well-bore casing or liner.

37. A centraliser apparatus as claimed in either of claims 34 or 35, wherein the tubular section is a length of production tubing.

38. A centraliser apparatus as claimed in either of claims 34 or 35, wherein the tubular section is a screen.

39. A centraliser apparatus as claimed in any of claims 34 to 38, wherein the at least one centraliser is located so as to surround the tubular section, such that the tubular

section is located within the at least one centraliser.

40. A centraliser apparatus as claimed in any of claims 34 to 39, wherein the at least one centraliser is located relative to the tubular section by means of a collar.

41. A centraliser apparatus as claimed in any of claims 34 to 40, wherein the at least one centraliser is located relative to the tubular section and is rotatable relative to the tubular section around a longitudinal axis thereof.

42. A method of fixing a casing or liner into a well-bore, the method comprising the steps of:

providing a well casing/liner;

providing at least one centraliser, the/each centraliser comprising a tubular body, a portion of an outermost surface of said tubular body being formed from a first material and a portion of or adjacent to at least one end of said tubular body and/or an innermost surface of said tubular body being formed from a second material, the first material having a lower Youngs modulus than the second material;

locating the at least one centraliser on the casing/liner at a desired position so as to provide a centralising apparatus;

placing the centralising apparatus within the well-bore; and

pumping cement slurry or the like into an annular space between an exterior of the casing/liner and the wellbore.

43. A method of completing a well, the method comprising the steps of:

providing a length of production tubing;

providing at least one centraliser, the/each centraliser comprising a tubular body, a portion of an

outermost surface of said tubular body being formed from a first material and a portion of or adjacent to at least one end and/or an innermost surface of said tubular body being formed from a second material, the first material having a lower Youngs modulus than the second material;

locating the at least one centraliser on the production tubing at a desired position so as to provide a centralising apparatus;

placing the centralising apparatus within a cased or lined well-bore.

44. A method as claimed in claim 43, wherein the method comprises the further step of:

securing a bottom of a length of the production tubing with a packer to seal the tubing to a casing/liner.

45. A method of gravel packing a well, the method including the steps of:

providing a screen;

providing at least one centraliser, the/each centraliser comprising a tubular body, a portion of an outermost surface of said tubular body being formed from a first material and a portion of or adjacent to at least one end and/or an innermost surface of said tubular body being formed from a second material, the first material having a lower Youngs modulus than the second material;

locating the at least one centraliser on the screen to provide a centralising apparatus;

placing the centralising apparatus within a borehole or perforated casing.

46. A method as claimed in claim 45, wherein the method comprises the further step of:

placing sand into an annular space between an exterior of the screen and the well-bore or perforated casing.

47. A drilltool or downhole tool having a tubular body, a portion of an outermost surface of said tubular body being formed from a first material and a portion of or adjacent to at least one end of said tubular body, and/or a portion of an innermost surface of said tubular body being formed from second material(s), the first material having a lower Youngs modulus than the second material.

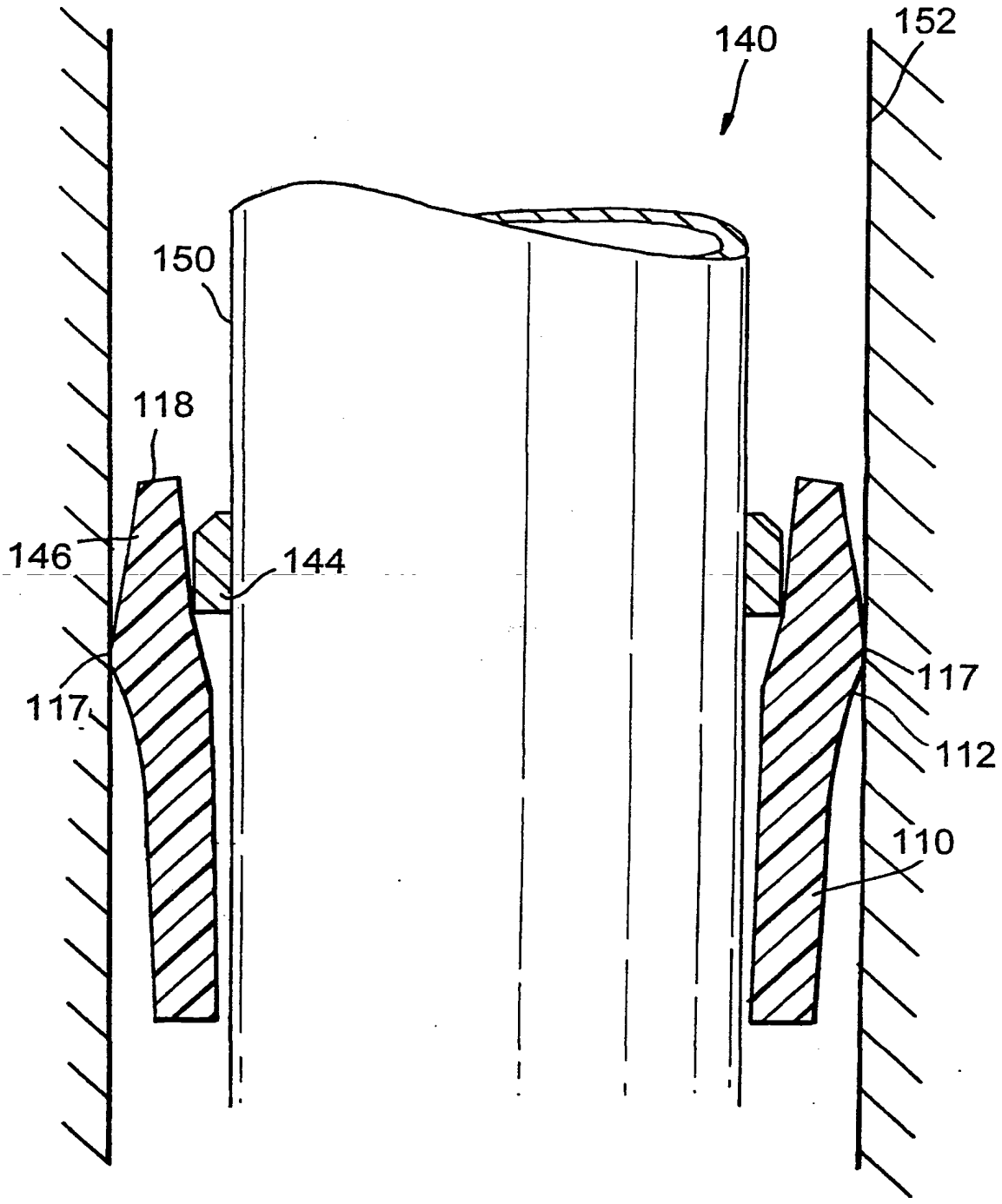

Fig. 1

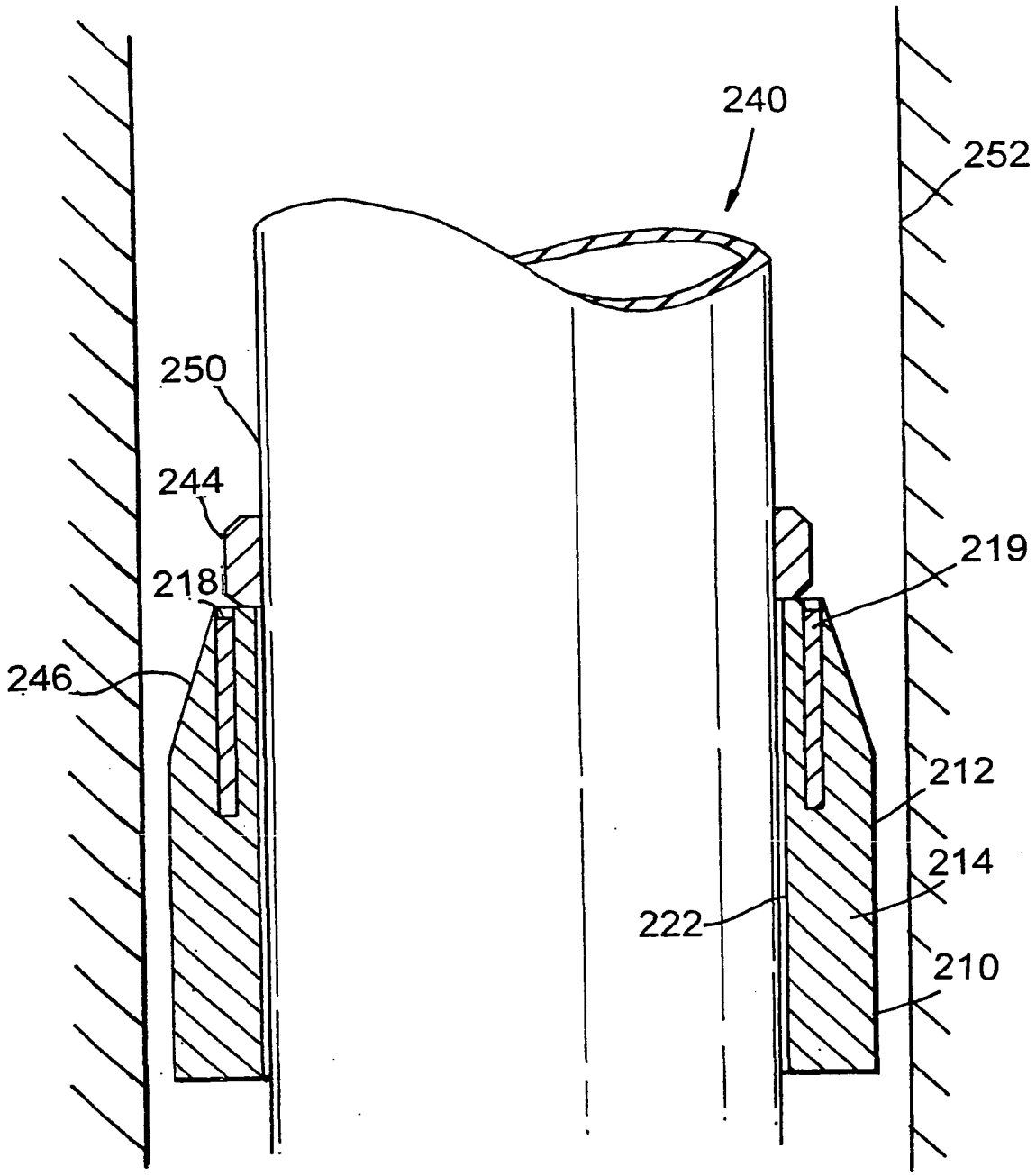

Fig. 2

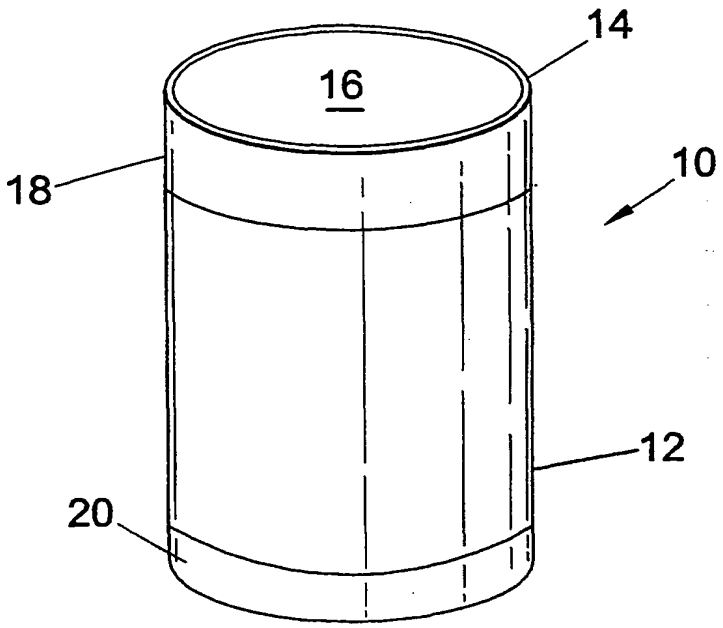

Fig. 3

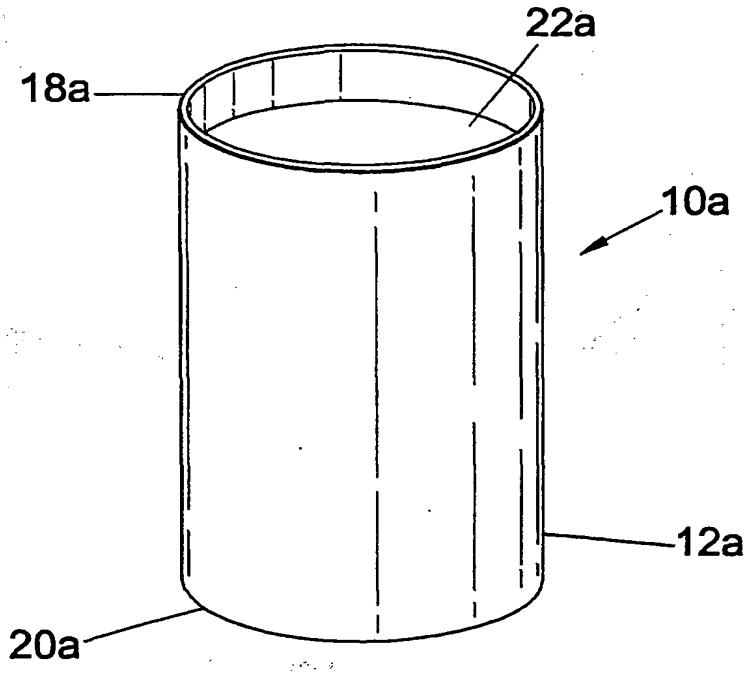

Fig. 4

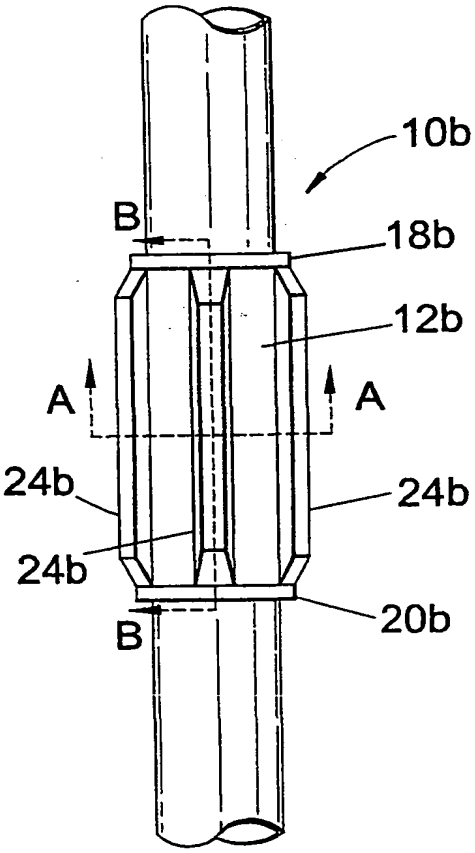

Fig. 5

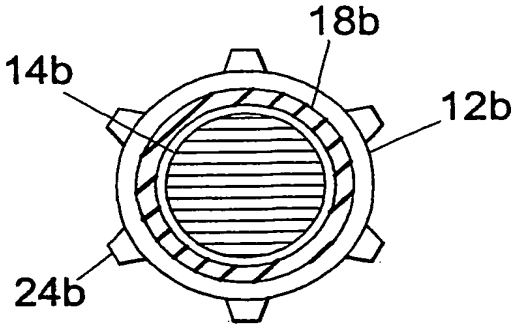

Fig. 6a

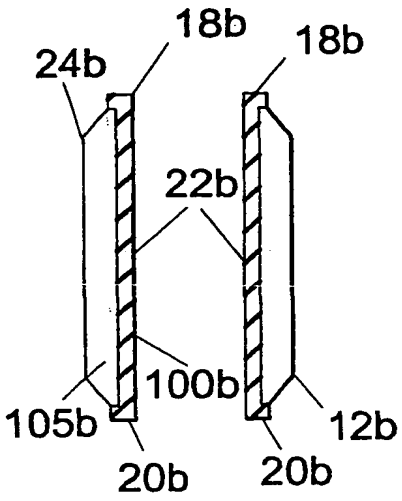

Fig. 6b

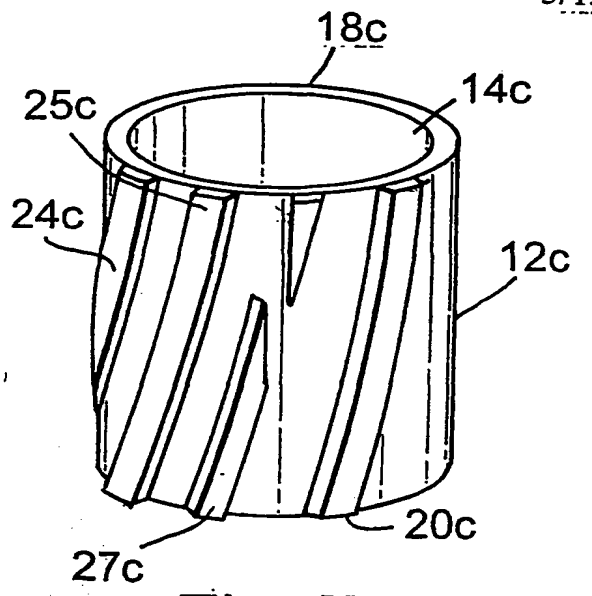

Fig. 7a

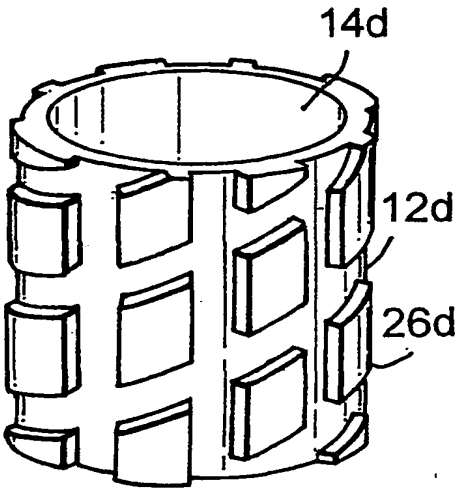

Fig. 7b

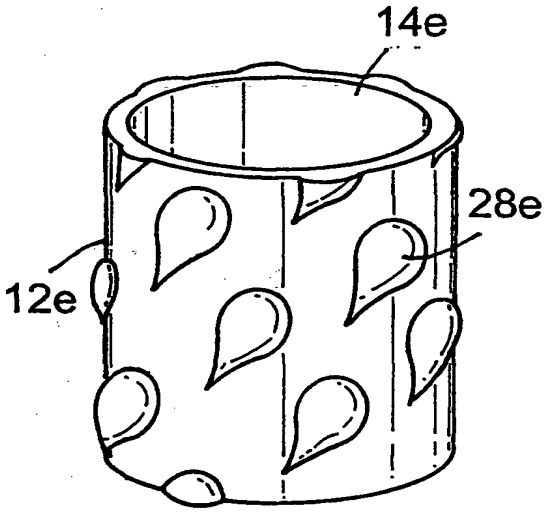

Fig. 7c

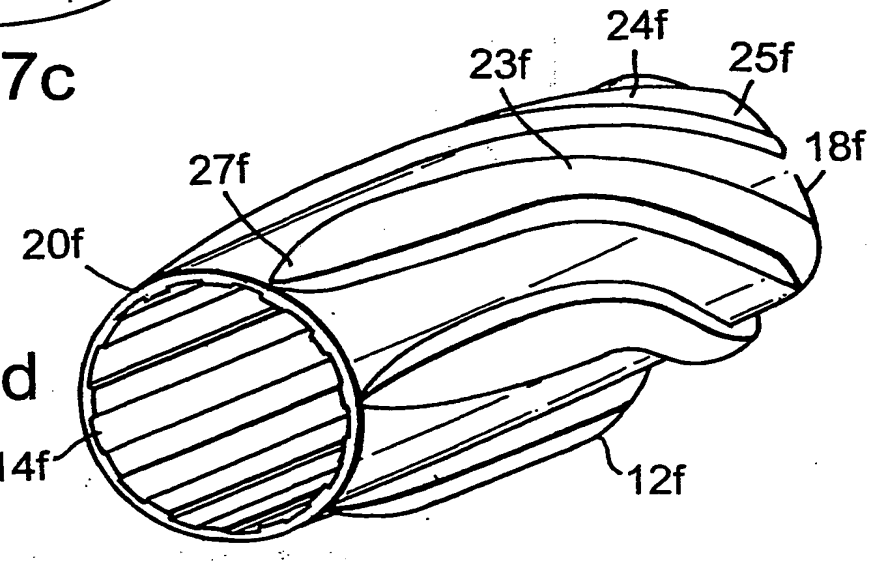

Fig. 7d

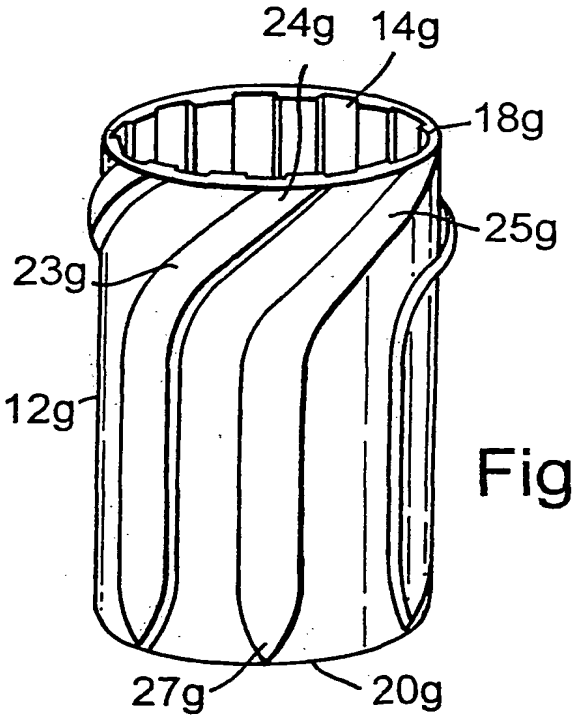

Fig. 7e

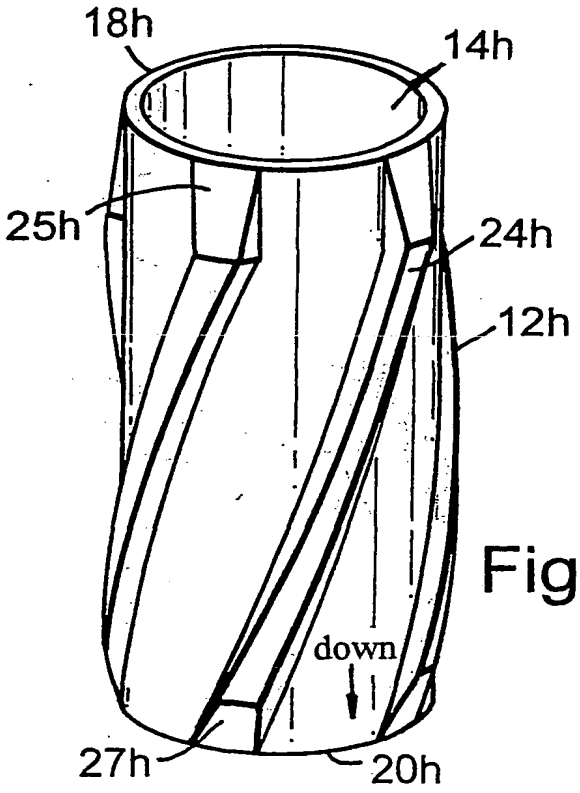

Fig. 7f

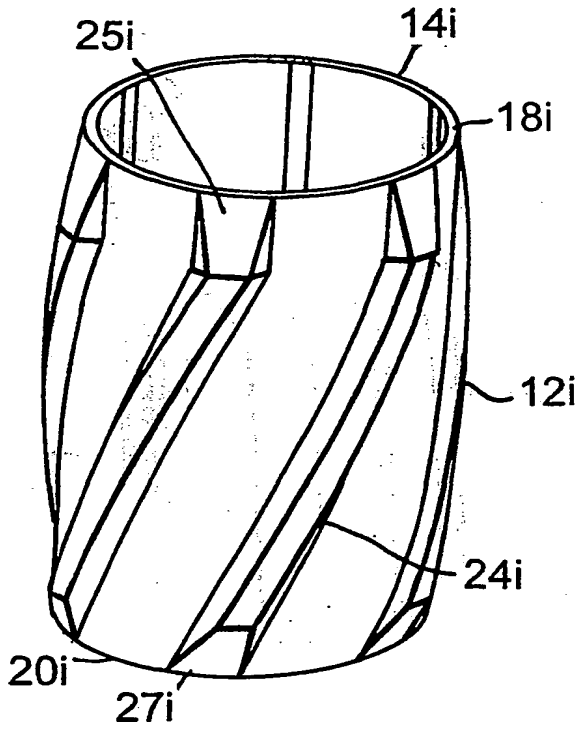

Fig. 7g

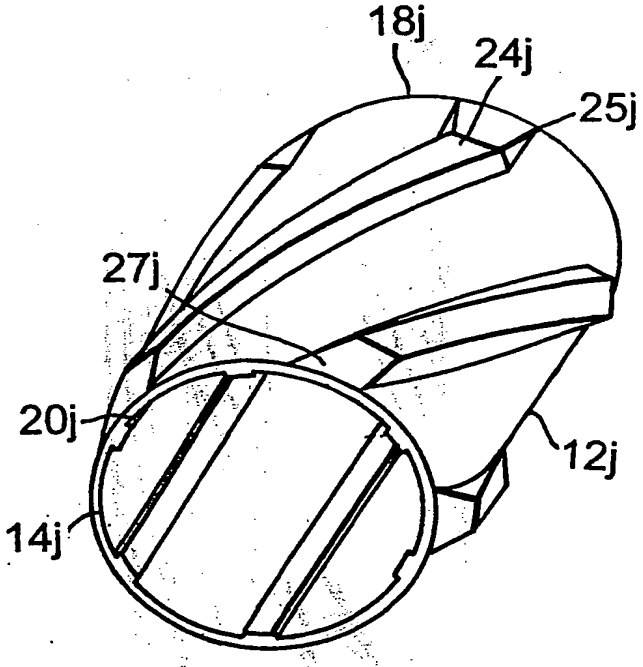

Fig. 7h

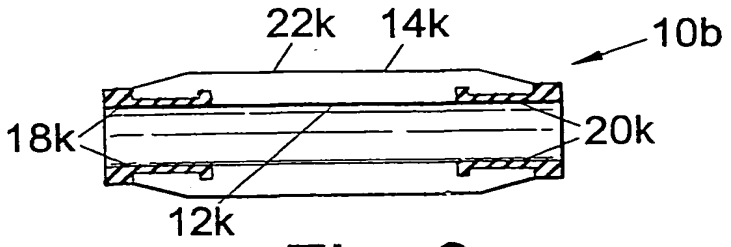

Fig. 8a

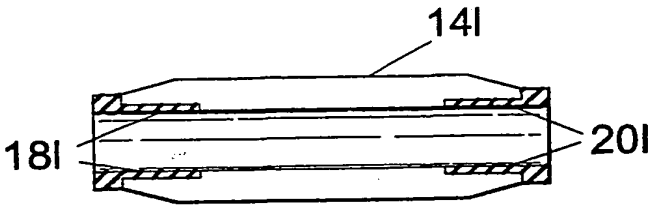

Fig. 8b

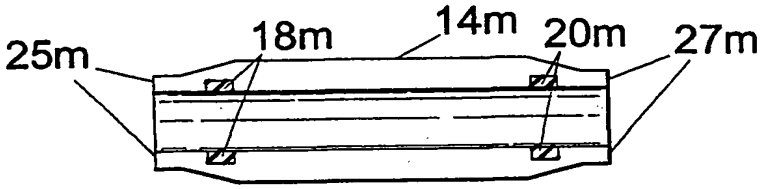

Fig. 8c

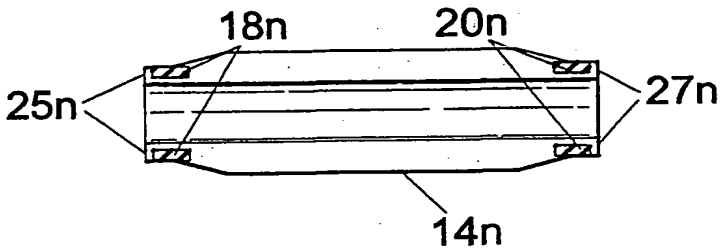

Fig. 8d

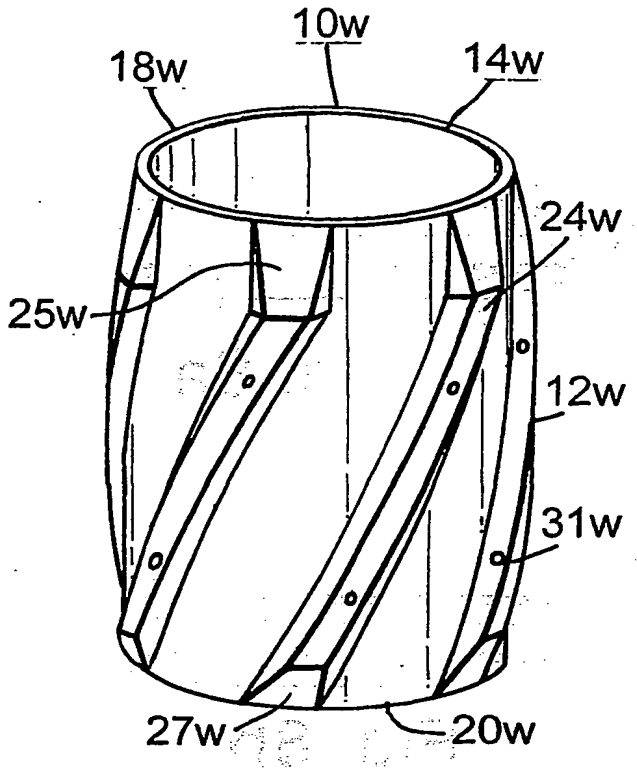

Fig. 9

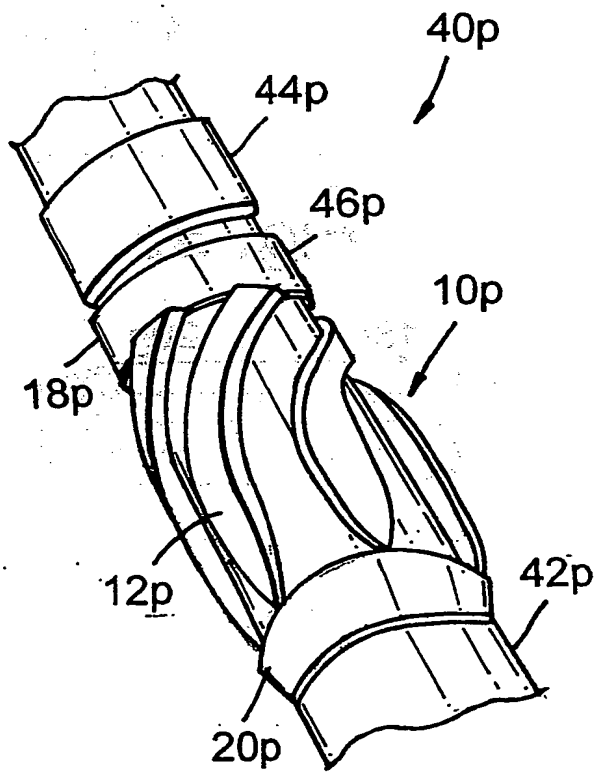

Fig. 10

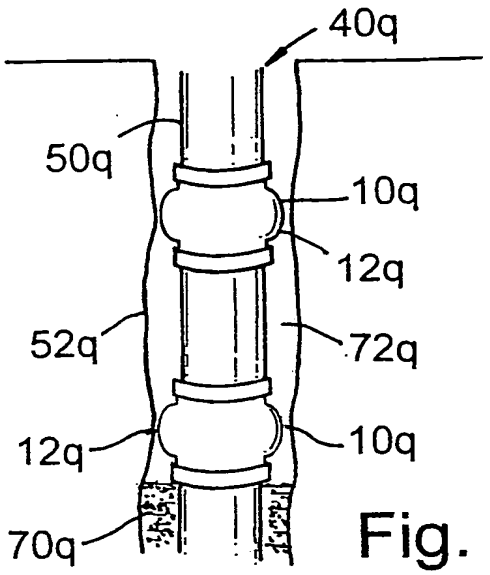

Fig. 11

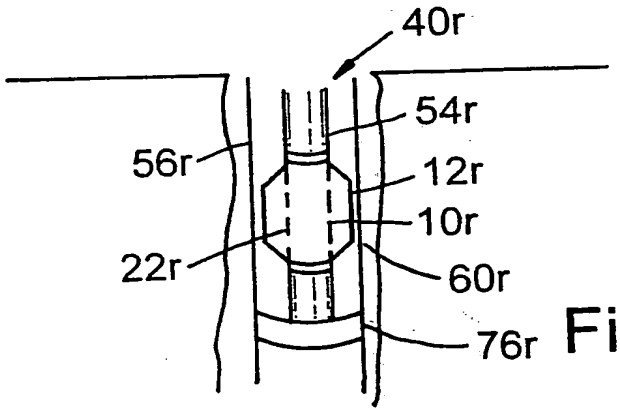

Fig. 12

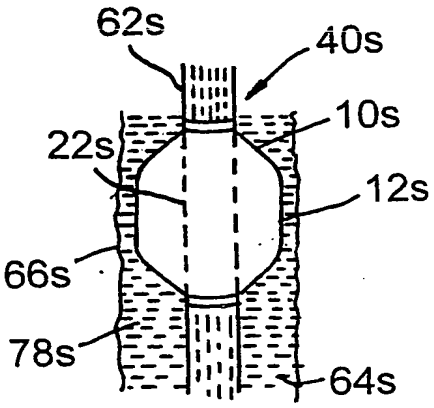

Fig. 13a

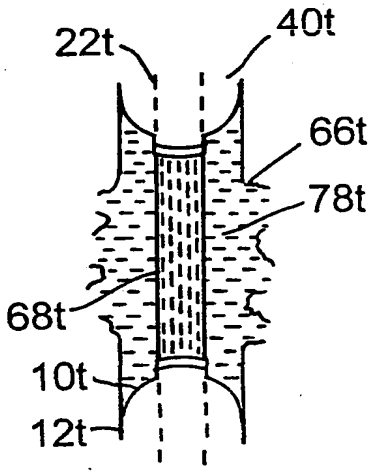

Fig. 13b

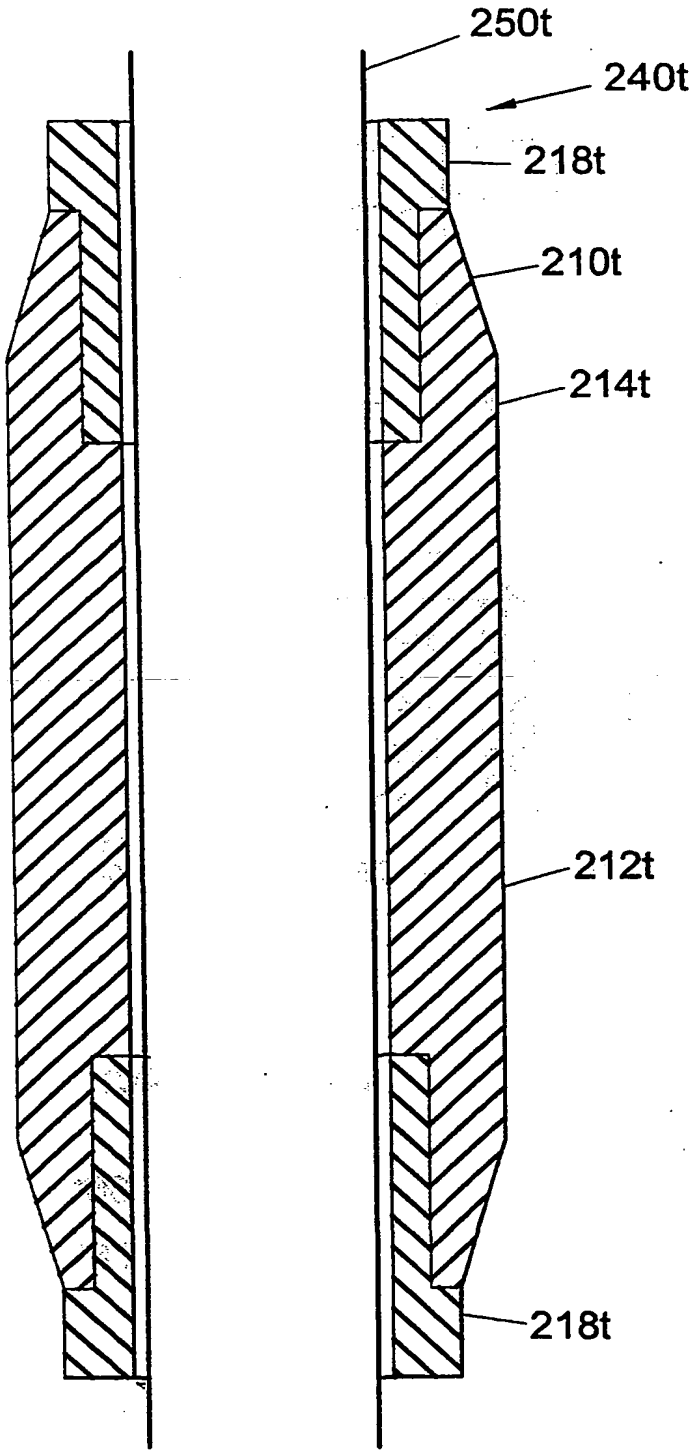

Fig. 14(a)

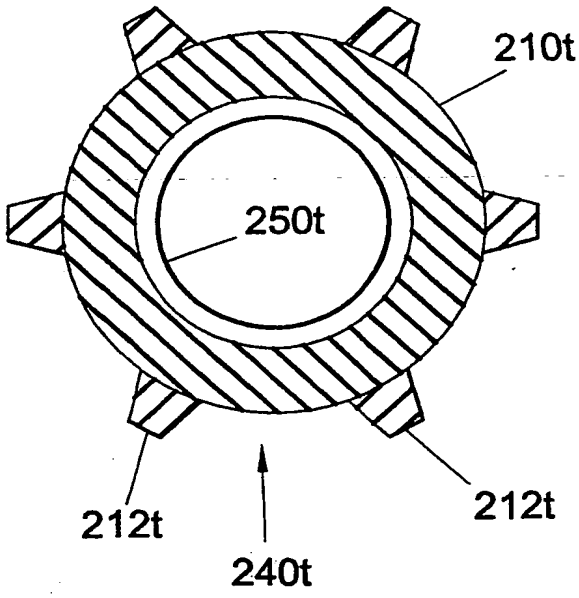

Fig. 14(b)

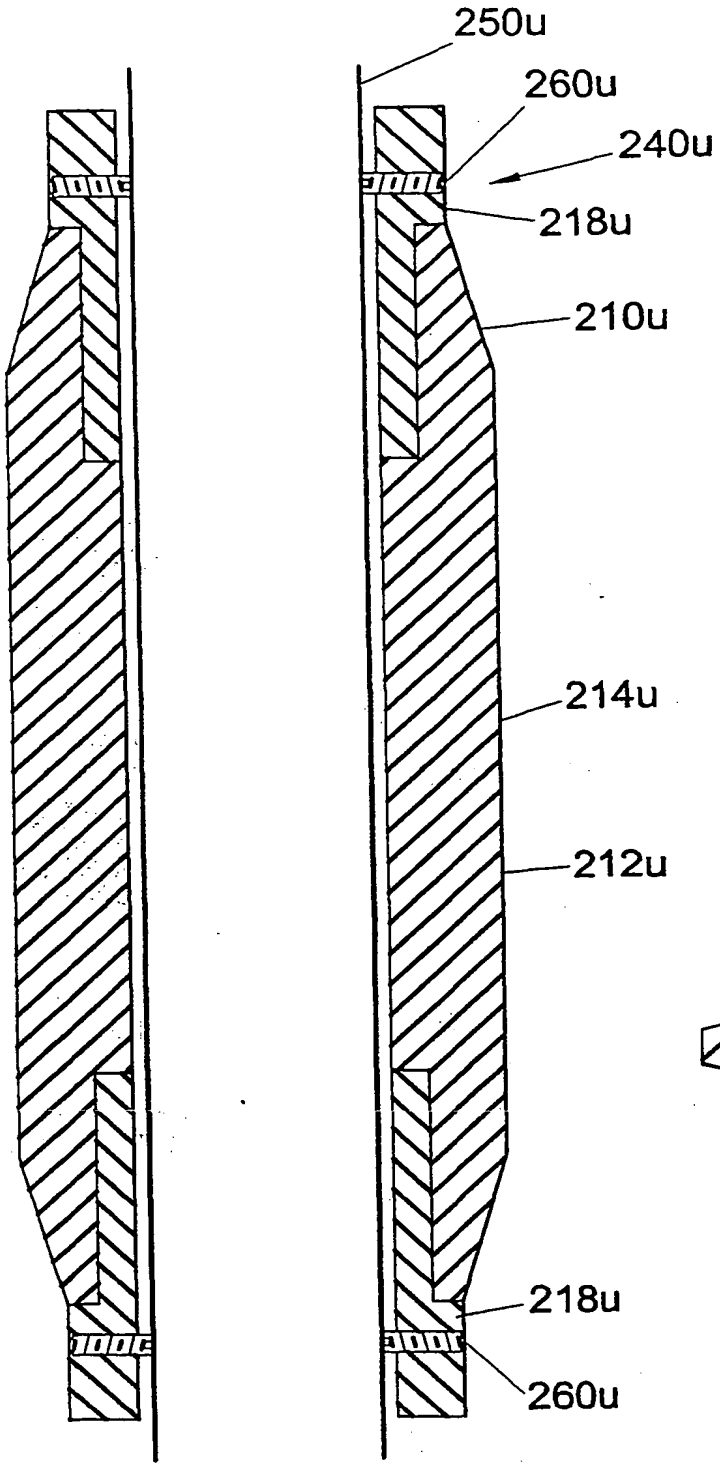

Fig. 15(a)

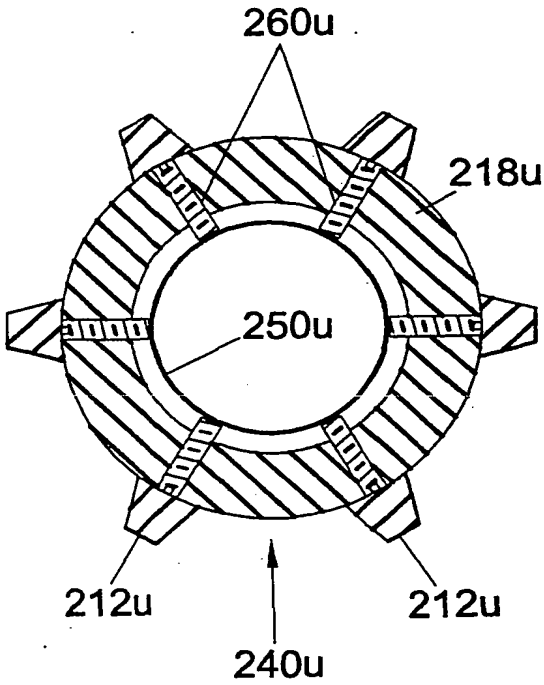

Fig. 15(b)

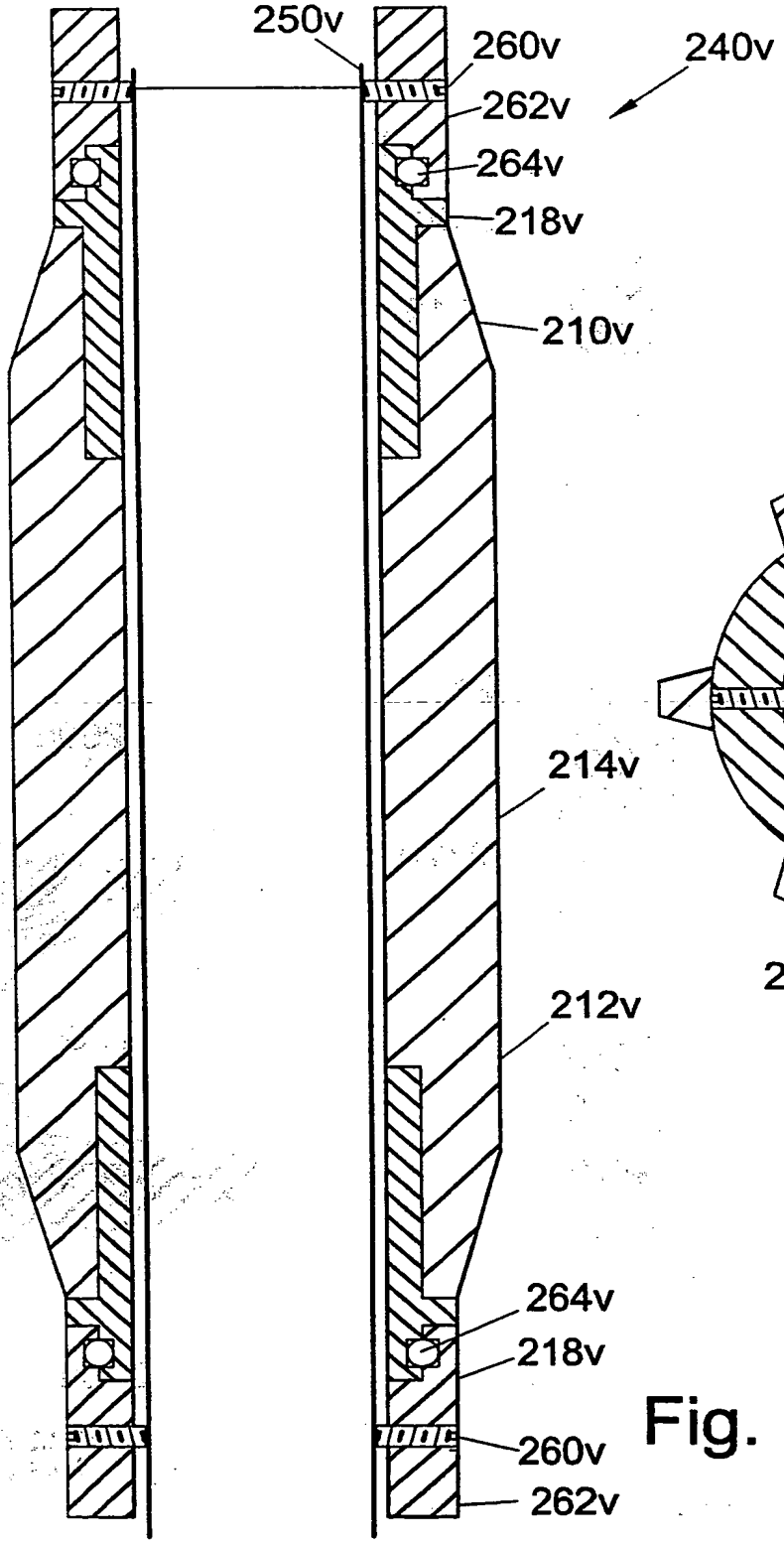

Fig. 16(a)

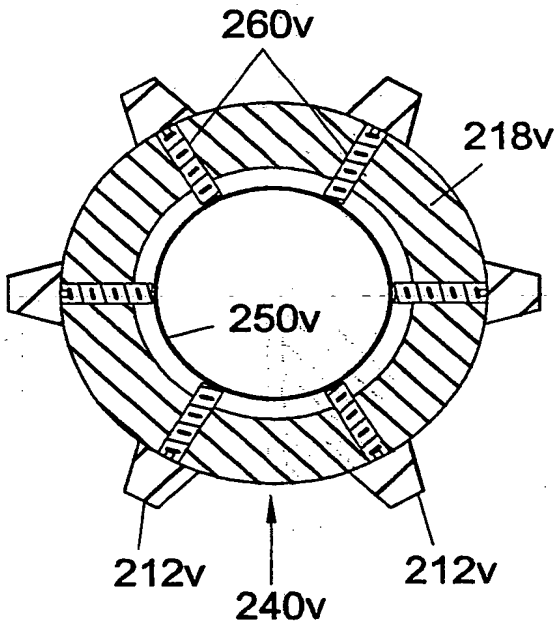

Fig. 16(b)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/02855

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 E21B17/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
E	GB 2 358 418 A (DOWNHOLE PRODUCTS PLC) 25 July 2001 (2001-07-25) page 2, line 1 - line 5; figure 1 page 3, line 14 - line 20 page 4, line 20 -page 5, line 6; claims 1,7,11	1-4, 6-13, 23-26, 34-46

X	WO 98 37302 A (DOWNHOLE PRODUCTS PLC ;KIRK IAN ALASTAIR (GB); BARRON WILLIAM (GB)) 27 August 1998 (1998-08-27) page 2, line 28 - line 33; figure 1 page 2, line 8 - line 18; claim 7	1-4, 6-13,23, 25,26, 34-46
Y		14,24, 27-30

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
5 September 2001	18. 12. 2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Dantinne, P

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 01/02855

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 99 25949 A (BRUNEL OILFIELD SERV UK LTD ;CHARLTON STEPHEN (GB)) 27 May 1999 (1999-05-27) cited in the application page 4, line 20 - line 23; figure 1 page 7, line 2 - line 28 ---	14,24
Y	US 5 833 018 A (VON GYNZ-REKOWSKI GUNTHER) 10 November 1998 (1998-11-10) column 3, line 20 - line 59; figure 2 ---	27-30
A	US 6 032 748 A (DEBRAY HAROLD J ET AL) 7 March 2000 (2000-03-07) column 2, line 64 -column 3, line 67; figure 2 ---	1,2,34, 42,43,45
A	GB 2 211 225 A (EXXON PRODUCTION RESEARCH CO) 28 June 1989 (1989-06-28) page 6, line 10 - line 15; figure 3 ---	1,2,34, 42,43,45
A	US 3 268 275 A (W.N.LAUGHLIN) 23 August 1966 (1966-08-23) column 3, line 25 - line 38; figures 5,11 column 3, line 71 -column 4, line 3 ---	1,2,34, 42,43,45
A	US 2 368 415 A (GRANT JOHN M) 30 January 1945 (1945-01-30) page 2, column 2, line 1 - line 11; figure 5 -----	1,2,34, 42,43,45

INTERNATIONAL SEARCH REPORT

International application No.
PCT/GB 01/02855

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-14, 23-30, 34-46

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-14,23-30,34-46

   A centraliser made from two different materials to combine increased stiffness and strength as well as low friction and abrasion resistance and method of its use

2. Claims: 1,2,15-22

   A centraliser characterised by its shape

3. Claims: 1,2,31-33

   A method of making a centraliser

4. Claim : 47

   A downhole tool made of two different materials

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/GB 01/02855

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
GB 2358418	A	25-07-2001	AU	2690901 A	31-07-2001
			WO	0153652 A1	26-07-2001
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			EP	1030957 A2	30-08-2000
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			NO	884376 A	17-04-1989
US 3268275	A	23-08-1966	NONE		
US 2368415	A	30-01-1945	NONE		

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0016145.5 30 June 2000 (30.06.2000) GB

(71) Applicant *(for all designated States except US)*: **BRUNEL OILFIELD SERVICES (UK) LIMITED** [GB/GB]; 9 Burford Lane, Lymm, Cheshire WA13 0SE (GB).

(72) Inventor; and

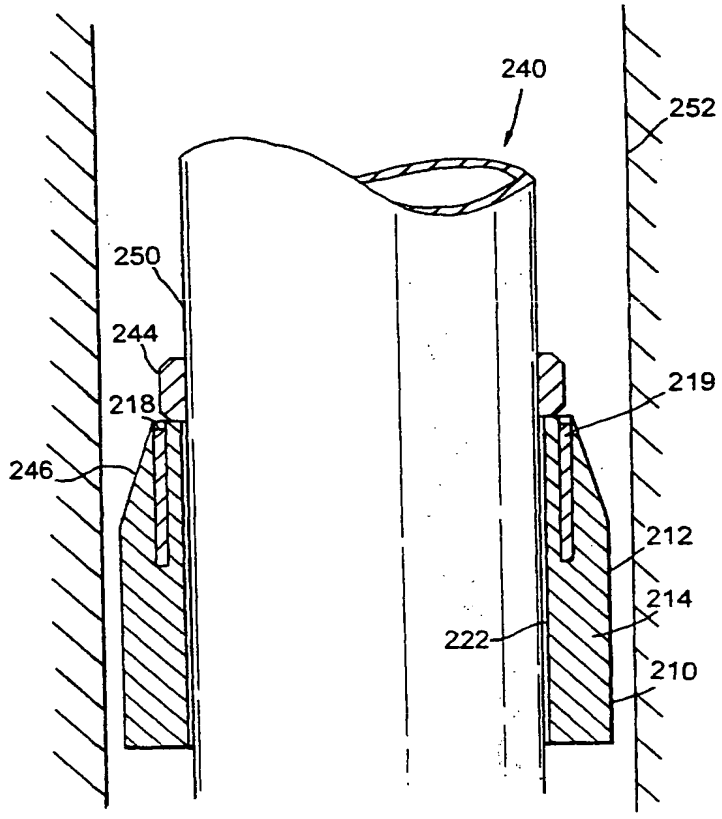
(75) Inventor/Applicant *(for US only)*: **THORNTON, Thomas, John, Oliver** [GB/GB]; 9 Burford Lane, Lymm, Cheshire WA13 0SE (GB).

(74) Agents: **MCCALLUM, William, Potter** et al.; Cruikshank & Fairweather, 19 Royal Exchange Square, Glasgow G1 3AE (GB).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

[Continued on next page]

(54) Title: COMPOSITE CENTRALISER



(57) Abstract: There is disclosed an improved centraliser (210) for centralisation of tubulars (250) such as casings, liners, production tubing, production screens and the like, in oil/gas wells. Known centralisers are of a "unitary construction", i.e. made in one piece fro m one material. This provides numerous problems in the prior art since the chosen material must provide conflicting characteristics at different times and places. Accordingly, the invention provides a centraliser (210) comprising a tubular body (214), a portion of an outermost surface (212) of said tubular body (214) being formed from a first material and a portion of or adjacent to at least one end (218) of said tubular body and/or a portion of an innermost surface (222) being formed from second material(s), the first material having a lower Youngs modulus than the second material(s).

WO 02/02904 A1

(84) **Designated States** *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report*

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

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(15) **Information about Correction:**
see PCT Gazette No. 09/2002 of 28 February 2002, Section II

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